WIND RIVER BASIN PROVINCE (035)

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With a section on coalbed gas by Ronald C. Johnson and Dudley D. Rice

INTRODUCTION

The Wind River Basin is a west-east-trending asymmetrical intermontane basin of the Rocky Mountain Foreland, located in central Wyoming. Province boundaries are defined by fault-bounded Laramide uplifts that surround it. These include the Owl Creek Mountains to the north, Wind River Mountains to the west, Casper Arch to the east, and the Sweetwater Uplift to the south. The Wind River Basin Province is about 200 mi long and 100 mi wide, encompassing an area of about 11,700 sq mi·

Approximately 0.53 BBO, 32 MMBNGL, and 2.5 TCFG are known (as of year-end 1990) since the first field, Dallas Dome, was discovered in 1884. After that first discovery, other anticlinal structures with strong surface features were soon discovered, including Lander (1912), Notches (1916), Poison Spider (1917), and Big Sand Draw (1918). Major structural fields include Beaver Creek (58.5 MMBO and 660 BCFG), Winkleman Dome (95 MMBO), Steamboat Butte (92 MMBO), Big Sand Draw (56 MMBO and 160 BCFG), Circle Ridge (33.2 MMBO) and Riverton Dome (174 BCFG). Major structures also occur in the deep basin area. The largest of these is Madden field, discovered in 1957 (825 BCFG). Other large fields include Boone Dome (42 BCFG), Frenchie Draw (46.5 BCFG), Pavillion (174 BCFG), and Waltman-Bull Frog (96 BCFG). A major exception to structurally entrapped hydrocarbons in the Wind River Basin is Grieve field, discovered in 1954, which includes stratigraphically trapped hydrocarbons in the Muddy Sandstone (30 MMBO; 117 BCFG). Other Muddy stratigraphic fields include Wallace Creek, discovered in 1960 (13.8 BCFG), and Sun Ranch, discovered in 1987 (3.0 MMBO and 7.5 BCFG).

Plays in this basin are defined by both structural and stratigraphic traps and occur in primarily Permian, Cretaceous, and Tertiary source rock and reservoir systems. Conventional plays individually assessed and treated in the following discussion include: Basin Margin Subthrust (3501), Basin Margin Anticline (3502), Deep Basin Structure (3503), Muddy Sandstone Stratigraphic (3504), and Phosphoria Stratigraphic (3506).

Other associations, listed as conventional plays, having trapping potential and in some cases having yielded small amounts of oil or gas include: Bighorn Wedge-Edge

Pinchout (3509), Flathead-Lander and Equivalent Sandstone Stratigraphic (3510), Madison Limestone Stratigraphic (3511), Darwin-Amsden Sandstone Stratigraphic (3512), Triassic and Jurassic Stratigraphic (3513), Shallow Tertiary-Upper Cretaceous Stratigraphic (3515), and Cody and Frontier Stratigraphic (3518). These plays were considered but not individually assessed. The Sub-Absaroka Play (3405) is present in this province but is described in the Big Horn Basin Province (034). Unconventional plays include the continuous-type Basin-Center Gas Play (3505) and the coalbed gas play, Wind River Basin–Mesaverde Play (3550) described by R.C. Johnson and D.D. Rice. A further explanation of coalbed gas may be found in the chapter by D.D. Rice in part I of this CD-ROM.

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CONVENTIONAL PLAYS

3501. BASIN MARGIN SUBTHRUST PLAY

Laramide basin-margin thrusting has trapped oil and gas in upturned, overturned, folded, and faulted Phanerozoic strata below the overthrust wedge. The limits of this demonstrated play are defined by the leading edge of basin-margin thrust faults and an assumed overhang displacement of 6 mi.

Reservoirs: Reservoir type and quality are highly variable. Porous and permeable sandstone and carbonate facies may have good reservoir quality. Also, some of the less conventional lithotypes may have good reservoir quality due to extensive fracturing associated with thrusting. Reservoirs can be any age, but principal reservoirs are the Pennsylvanian Tensleep Sandstone, Permian Phosphoria carbonates, and Cretaceous Frontier sandstones.

Source rocks: Hydrocarbons in the Wind River Basin are of three geochemical source rock classes, Permian (Phosphoria Formation), Cretaceous (Mowry, Frontier, Mesaverde, Meeteetse Formations), and Tertiary (Fort Union Formation).

Timing and migration: Because Laramide thrust faults have thrust thick wedges of Precambrian rocks over Phanerozoic rocks, the depth of the source rocks is usually great enough for the source rocks to have generated hydrocarbons locally or for hydrocarbons to have migrated from mature areas in deeper parts of the basin during and after Laramide deformation. Some pre-Laramide migration may have taken place, moving hydrocarbons into reservoirs before tectonic development of the basin-margin folds and faults. In this case stratigraphic traps could have formed prior to basin-margin thrusting and subsequent development of basin-margin folds and faults. Faulting could then have superimposed structural control on these stratigraphic traps.

Traps: Petroleum is trapped where structures with closure occur beneath the basin-margin thrust and is sealed by associated rocks or by impermeable rocks of the hanging wall of the thrust. In the thrusting process the underlying beds are folded and often upturned or overturned with fault slivers typically present. Oil and gas may also be trapped in these upturned, overturned, folded, and faulted strata. Depth to production is highly variable, ranging from more than 20,000 ft on the structurally steepest side of the asymmetrical basin to less than 10,000 ft in other basin-margin areas.

Exploration status: This demonstrated play is very lightly explored. One field, Tepee Flats field, is currently producing gas from the Frontier Formation at a depth of about 12,200 ft.

Resource potential: It is anticipated that about 2/3 of the fields in this play will be gas fields occurring in deeper parts of the basin, and the remaining 1/3 will be oil fields in areas where entrapment is shallower. Known recoverable from the Tepee Flats field is 9.0 BCFG.

3502. BASIN MARGIN ANTICLINE PLAY

This demonstrated play is defined by the occurrence of oil and gas trapped in anticlines and domes, in many cases faulted, and in faulted fold noses that formed during the Laramide orogeny. These structures are best developed along the shallow margins of the basin, with production from about 1,000 ft to about 14,000 ft. The inner boundary of the play is drawn at the approximate basinward limit of basin-margin anticlines. The outer boundary is drawn at the top of the Tensleep on outcrop.

Reservoirs: Producing formations range in age from Mississippian through Cretaceous and include Madison, Tensleep, Phosphoria, Crow Mountain, Jelm, Sundance, Nugget, Dakota, Cloverly, Lakota, Muddy, Frontier, Cody, and Mesaverde. Primary production has been from the Madison, Tensleep, and Phosphoria. Many of the fields have multiple pay zones and some show common oil-water contacts involving several of the Paleozoic reservoirs. Sandstone is the dominant reservoir lithology, in most cases relatively homogeneous and of good reservoir quality. Substantial quantities of hydrocarbons have also been produced from heterogeneous carbonate reservoir rocks of the Madison and Phosphoria. Reservoir thickness is highly variable: individual units reach a thickness of several hundred feet. Most reservoirs, however, are less than 50 ft thick.

Source rocks: Within the thick sequence of hydrocarbon-bearing strata are numerous organic-rich argillaceous sedimentary rocks. Hydrocarbons are derived from three distinct geochemical source rock classes, Permian (Phosphoria Formation), Cretaceous (Mowry, Frontier, Mesaverde, Meeteetse Formations), and Tertiary (Fort Union Formation). Oil and gas in the Cretaceous reservoirs have their source in associated Cretaceous organic-rich beds, whereas Paleozoic oil and gas appear to be derived primarily from a distinct Phosphoria source. Two fields in the western part of the basin, Circle Ridge and Beaver Creek, produce oil from the Madison Limestone.

Properties of the oil in these two fields are nearly identical to those of the Tensleep and Park City (Phosphoria) oil in the same areas, indicating that the oil may have been derived from the younger Paleozoic sources or reservoirs. The thermal maturity is high in many areas of the basin, especially where source beds are very deeply buried, and in these areas the dominant hydrocarbon is gas.

Timing and migration: Pre-Laramide generation and long-distance migration from western Wyoming prior to basin formation, followed by remigration during the Laramide orogeny, is a possibility for charging of Paleozoic reservoirs. However, local generation of oil also occurred without long-distance migration. Cretaceous source rocks reached maturity by early Paleocene time in deep parts of the basin, and younger rocks later entered the hydrocarbon generation window. Structural growth apparently coincided with this Laramide stage of maturation and was the final concentrating process in a long and complex history of generation, migration, and accumulation of hydrocarbons.

Traps: Trapping mechanism is closure in both anticlines and domes, in many cases faulted, and in faulted fold noses that formed during the Laramide orogeny. These structures are best developed around the shallow margins of the basin, with production from a few hundred feet to about 12,000 ft. Within these structures, interbedded impermeable beds act as seals.

Exploration status: Approximately 0.53 BBO, 32 MMBNGL, and 2.53 TCFG have been discovered (as of year-end 1990) since the first field, Dallas Dome, was discovered in 1884. Since that first discovery, other basin-margin anticlinal structures with strong surface features were soon discovered, including Lander (1912), Notches (1916), Poison Spider (1917), and Big Sand Draw (1918). Major structural fields include Beaver Creek (58.5 MMBO and 660 BCFG), Winkleman Dome (95 MMBO), Steamboat Butte (92 MMBO), Big Sand Draw (56 MMBO and 160 BCFG), and Riverton Dome (174 BCFG).

Resource potential: Most large traps had been explored by about 1950. Prospects for significant new discoveries are not good, although new production could occur as extensions and secondary features related to larger structural trends. Small fields are likely. The mix of oil and gas should be in about the same proportion as historic.

3503. DEEP BASIN STRUCTURE PLAY

This is a demonstrated gas play with entrapment in large intrabasin anticlinal, domal, and fold nose structures within the deep axial portion of the basin. The boundary of this play is defined on the north by the leading edge of the northern basin-margin thrust fault and on the south and west by the deep limit of the Basin Margin Anticline Play (3502).

Reservoirs: Reservoir rocks range in age from Mississippian to Eocene and include the Madison, Phosphoria, Nugget, Morrison, Cloverly, Muddy, Frontier, Cody, Mesaverde (Fales Sandstone), Lance, Fort Union, and Wind River. Porosity and permeability, reduced through compaction and cementation due to deep burial, may be re-enhanced by fracturing. Early migration and entrapment may have preserved some of the original porosity and permeability. Most fields have multiple pool production from a great range of depths and thicknesses. Reservoir thickness is highly variable, ranging from a few feet to 280 ft in the Fort Union Formation. Most reservoirs are about 25–50 ft thick. Reservoirs may be overpressured; for example, most Tertiary and Mesozoic strata on the Madden structure are overpressured but nearly normal pressure gradients occur near the top of the Paleozoic interval. Reservoir rocks are interbedded with source rocks, facilitating migration.

Source rocks: Indigenous hydrocarbon source rocks are abundant in the Permian Phosphoria and the Cretaceous Mowry, Frontier, Mesaverde, Meeteetse, Tertiary Fort Union (including Waltman Shale Member), Wind River, and Indian Meadows.

Timing and migration: Vitrinite reflectance studies indicate that both oil and gas generation began from the Cody, Mesaverde, and Meeteetse source rocks in the early Paleocene. Paleozoic source beds were buried deeply enough to generate hydrocarbons before the Laramide orogeny. Gas accumulations in Paleozoic strata were probably oil earlier in the development of the structure: these reservoirs passed through the oil window with continued burial and produced large quantities of thermogenic gas. Laramide folding was the final concentrating process in a long and complex history of generation, migration, and accumulation of hydrocarbons.

Traps: The primary trapping mechanisms in this play are intrabasinal anticlinal, domal, and fold nose structures within the deep axial portion of the basin. Seals include fine-grained facies interbedded with reservoirs, some of which may also be source beds. Depth of production ranges to more than 23,000 ft. At Madden field, gas is produced from the Madison Limestone at about 23,700 ft.

Exploration status: This demonstrated play is moderately well explored to well explored. About 10 fields with ultimate production in the category of greater than 1 MMBOE (6 BCFG) are currently producing in this play. The largest field is Madden field, discovered in 1957 (825 BCFG). Other large fields include Boone Dome (42 BCFG), Frenchie Draw (46.5 BCFG), Pavillion (174 BCFG), and Waltman-Bull Frog (96 BCFG).

Resource potential: Potential for undiscovered resources may be good in this play. Reserve estimates of many of the currently discovered fields do not include Paleozoic units such as the Madison Limestone, which is a major new reservoir at Madden field. Although quality of this gas is not good, being high in hydrogen sulfide and carbon dioxide, considerable potential exists for other productive Paleozoic reservoirs, as well as shallower zones, elsewhere in the basin.

3504. MUDDY SANDSTONE STRATIGRAPHIC PLAY

This is a stratigraphic play with anticipated entrapment of oil and gas in updip pinchouts of discontinuous Muddy Sandstone bodies, deposited as a complex series of coastal sand bodies whose distribution was controlled by paleotopography and structure. The limits of this play are defined on the south and west by outcrop limits of the Muddy Sandstone and on the north by excessive depth, the limit line coincident with the southern shallow limit line of the Basin Center Structure Play (3503). The actual sandstone may, in fact, extend beyond the limits of the play but is restricted due to excessive depth and anticipated reservoir degradation in the deeper parts of the basin. Here it may be a gas play, and it was assessed within the Basin Center Structure Play (3503).

Reservoirs: The thickness of the Muddy is highly variable, as much as 150 ft in places along the west margin of the basin, locally thinning and grading almost completely into shale and siltstone. In known producing fields it ranges from 20 to 52 ft. The excellent reservoir quality and the high quality of the oil (33û to 43û API) make it a prime drilling objective. Porosity ranges from about 9 percent to 13 percent at depths to about 11,000 ft.

Source rocks: Source rocks for Muddy hydrocarbons are the organic-rich shales of the Mowry and Shell Creek Shales that overlie, and the Thermopolis Shale that lies below the Muddy Sandstone reservoir rocks. Depth of burial of the Muddy is in excess of 5,000 ft throughout the play area, a depth sufficient to generate hydrocarbons.

Timing and migration: The reservoir sandstone is closely associated with thick petroleum source beds, so that the conditions for primary entrapment of hydrocarbons are ideal. Vitrinite reflectance studies indicate that oil and gas generation both began from the Cody, Mesaverde, and Meeteetse source rocks, far above the Muddy, in the early Paleocene. The Mowry source beds may have generated hydrocarbons before the Laramide orogeny.

Traps: The trapping mechanism is updip pinchout of discontinuous reservoirs, such as in Grieve field, the largest Muddy field, where production is from an unusually thick section of estuarine sandstone that thins abruptly updip on the west where the petroleum is trapped. Depth of burial is from about 5,000 to 12,000 ft. At Wild Horse Butte field (discovered in 1985) the Muddy produces gas at a depth of 14,046 ft.

Exploration status: This demonstrated play is heavily explored along the southern margin of the basin but is lightly explored in the central or western part. Six fields greater than 1 MMBOE ultimately recoverable have been discovered. They include Austin Creek (discovered 1988), Grieve (discovered 1954), Grieve North (discovered 1973), Sun Ranch (discovered 1987), Wallace Creek (discovered 1960), and Wild Horse Butte (discovered 1985). Wallace Creek and Wild Horse Butte are primarily gas fields. Field sizes range from Grieve (30 MMBO and 117 BCFG), Sun Ranch (3.0 MMBO and 7.5 BCFG), Grieve North (4.5 MMBO and 6.6 BCFG), Austin Creek (1.5 MBO and 3.4 BCFG), and Wild Horse Butte (6.0 BCFG).

Resource potential: Considering the fairly recent discoveries of new fields in this play, its potential is good. Most future discoveries will be small to medium size.

3506. PHOSPHORIA STRATIGRAPHIC PLAY (HYPOTHETICAL)

High-sulfur oil (20û to 30û API gravity) is stratigraphically trapped in the Ervay Member of the Phosphoria Formation along a generally north-south trend or transition zone from Phosphoria carbonates on the west to red shale and evaporites of the Goose Egg Formation on the east. The play area is located in the eastern Wind River Basin, limits of the play defined on the east by the eastern limit of the Ervay Tongue, on the west by the estimated downdip limit of perceived oil accumulations, and on the north and south by Phosphoria outcrops.

Reservoirs: Reservoirs occur in the Permian Ervay Member of the Phosphoria Formation. They are typically dolomitized grainstones and packstones, along with local algal rocks containing fenestrate porosity. These reservoirs formed in high-energy tidal and associated environments. At Cottonwood Creek field, oil in high-energy tidal channels is sealed updip by tight fine-grained intertidal and supratidal carbonates.

Reservoir matrix porosities average about 10 percent, but are, in many places, fracture enhanced. Reservoir thickness ranges from about 25 to 75 ft.

Source rocks: Oil was generated from organic-rich Permian Phosphoria shale source rocks to the west where burial depth was sufficient to generate hydrocarbons.

Timing and migration: Both Laramide-related and pre-Laramide generation and migration of hydrocarbons may have occurred. Generation of oil from Phosphoria source rocks may have begun as early as the Jurassic in western Wyoming and eastern Idaho.

Traps: Stratigraphic traps occur near the edge of the carbonate tongue of the Ervay Member, in porous detrital reservoirs deposited within high energy regimes of tidal channels on a coastal flat. They were sealed updip by tight, fine-grained carbonates of intertidal and supratidal origin. Lateral seals for traps are the mud-supported carbonates of the Ervay Member, although the regional trap can be viewed as the facies change from carbonate into red beds. Vertical seals are the fine grained rocks of the overlying Triassic Dinwoody and Chugwater Formations, and internal seals are provided by fine-grained red beds or carbonates. Depth to producing horizons is estimated to be from about 2,000 to 20,000 ft.

Exploration status: Exploration of the Phosphoria Stratigraphic Play was stimulated by the discovery of Cottonwood Creek field in the Bighorn Basin in 1953. This large field has known reserves of 59 MMBO and 42 BCFG. Subsequent discoveries in the Bighorn Basin have been infrequent and smaller in size, approximately 10. Exploration success in the Wind River Basin has been disappointing, with discovery of only one or two very small accumulations.

Resource potential: Undiscovered pools are estimated to be of small size, probably averaging less than 1 MMBO.

3509. BIGHORN WEDGE-EDGE PINCHOUT PLAY (HYPOTHETICAL)

This hypothetical play encompasses hydrocarbon occurrence in the wedge-edge or beveled-edge pinchouts of the Ordovician Bighorn Dolomite which abut against the base of the Madison Limestone, providing potential traps. No hydrocarbon occurrences or source rocks are known.

Reservoirs: Reservoirs in the Bighorn Dolomite are characterized by intergranular porosity, and they are anticipated to be present over most of the play area.

Source rocks: Source rocks have not been identified associated with the hypothetical reservoir rocks. Their absence implies that exploration success could be nil.

Traps: Although regional truncation is demonstrated, the presence of traps at this unconformity is undocumented and internal traps not recognized.

Exploration status: No production exists within this play, and exploration has been minimal.

Resource potential: This play bears very high risk (probability of success is less than 0.1) owing to poor charge and trap potential. It is considered to have little likelihood of significant hydrocarbons. No quantitative estimate of resources was made.

3510. FLATHEAD-LANDER AND EQUIVALENT SANDSTONE STRATIGRAPHIC PLAY (HYPOTHETICAL)

This hypothetical play includes hydrocarbons trapped in stratigraphic pinchouts of the Cambrian Flathead and Ordovician Lander Sandstones. No hydrocarbon occurrences or source rocks are known.

Reservoirs: Reservoirs are sandstones that are believed to be present over much of the play area, but that exhibit considerable variability. Quality of reservoirs may be poor, owing to diagenesis.

Source rocks: Source rocks have not been identified associated with the hypothetical reservoir rocks. Their absence implies that chance of exploration success is extremely minimal.

Traps: Although stratigraphic pinchouts are anticipated, the presence of traps has not been demonstrated.

Exploration status: No production exists within this play.

Resource potential: This play bears very high risk owing to poor charge and trap potential. It is considered to have little likelihood of significant hydrocarbons. No quantitative estimate of resources was made.

3511. MADISON LIMESTONE STRATIGRAPHIC PLAY (HYPOTHETICAL)

This hypothetical play encompasses oil enclosed within or at the top of the Mississippian Madison Limestone, trapped by a combination of porosity variation and topography related to karst development.

Reservoirs: Karstic vuggy reservoirs in the upper part of the Madison Limestone are expected throughout the play area.

Source rocks: Source rocks have not been identified associated with the hypothetical reservoirs. Their absence implies very minimal chance of exploration success.

Traps: The presence of traps is not demonstrated.

Exploration status: No production exists within this play.

Resource potential: This play bears very high risk owing to poor charge and trap potential. It is considered to have little likelihood of significant hydrocarbons. No quantitative estimate of resources was made.

3512. DARWIN-AMSDEN SANDSTONE STRATIGRAPHIC PLAY (HYPOTHETICAL)

This hypothetical play consists of stratigraphic entrapment of oil in discontinuous sandstones of the Pennsylvanian Darwin and Amsden Formations. Although no occurrence of oil in such traps is here known, these formations are productive elsewhere in structural settings.

Reservoirs: Reservoirs are sandstones believed to be present over most of the play area. Quality of reservoirs may be poor owing to burial diagenesis.

Source rocks: Source rocks have not been identified with certainty associated with the hypothetical reservoirs. Their absence implies very minimal chance of exploration success.

Traps: Considerable variability of sandstone distribution exists within the Amsden, and the belief is that traps are enhanced by structural pinchouts.

Exploration status: No production exists within this play.

Resource potential: This play bears very high risk owing to poor charge and trap potential. It is considered to have little likelihood of significant hydrocarbons. No quantitative estimate of resources was made.

3513. TRIASSIC AND JURASSIC STRATIGRAPHIC PLAY (HYPOTHETICAL)

This hypothetical play encompasses stratigraphic traps in the Crow Mountain Sandstone and equivalent(?) Jelm Formation of the Chugwater Group, Sundance Formation, and Morrison Formation. It also includes wedge-edge pinchouts and truncations of the Nugget Sandstone in the eastern and northern Wind River Basin.

Reservoirs: Reservoirs are sandstones believed to be present over most of the play area. Quality of reservoirs is expected to be good.

Source rocks: Source rocks have not been identified with certainty associated with the hypothetical reservoirs. Charging of traps appears to require migration from source beds well above or below the objectives such as from the Phosphoria Formation.

Traps: The presence of traps is not demonstrated.

Exploration status: No production exists within this play.

Resource potential: This play bears very high risk owing to poor charge and trap potential. It is considered to have little likelihood of significant hydrocarbons. No quantitative estimate of resources was made.

3515. SHALLOW TERTIARY-UPPER CRETACEOUS STRATIGRAPHIC PLAY

Stratigraphic and combination traps contain primarily gas with some liquids in Eocene, Paleocene, and uppermost Cretaceous sandstone reservoirs.

Reservoirs: Reservoirs are Wasatch, Fort Union, Lance, and Mesaverde arkosic or lithic sandstones with good porosity and permeability at shallow depths.

Source rocks: Source rocks are primarily underlying Cretaceous and Paleocene rocks with some possible contribution from humic-rich rocks of Tertiary age. Gas appears to be thermogenic with some mixing of biogenic gas. Local oil has its source in the lacustrine Paleocene Waltman Shale. Vertical migration is necessary to charge the reservoirs..

Timing and migration: Timing of generation and migration is favorable in that traps were formed by the time of generation and migration.

Traps: Traps are primarily stratigraphic, the result of facies changes. They are typically alluvial sandstones that form localized channel bodies of limited extent. Traps are small and sometimes occur in combination with structures. Seals are provided by associated fine-grained rocks, variously Eocene, Paleocene, and Upper Cretaceous.

Exploration status: This play has been lightly explored for many years, and a number of small accumulations have been discovered.

Resource potential: Small accumulations (less than 1 MMBOE) are anticipated, and a risk was assigned to occurrence of larger accumulations.

3518. CODY AND FRONTIER STRATIGRAPHIC PLAY (HYPOTHETICAL)

This play includes deep oil and gas accumulations in stratigraphic traps in the Upper Cretaceous Cody and Frontier Formations, in a thick sequence of marine shale and fine-grained sandstone.

Reservoirs: Reservoirs of fine-grained sandstone are distributed throughout the play area. Reservoir quality is anticipated to rapidly decrease with depth. Although equivalent reservoirs are productive in structural settings, reservoir quality in deeper, off-structural settings of this play remains problematic.

Source rocks: Cretaceous source rocks (particularly the Mowry Shale) are present, associated with the reservoir rocks, and probably have seen a favorable hydrocarbon generation and migration history.

Traps: Stratigraphic pinchout traps involving largely marine sandstones may be distributed throughout the play area, but the presence of traps of significant size is not demonstrated.

Explorations status and resource potential: This play bears very high risk owing primarily to poor reservoir and limited trap potential. It is considered to have little likelihood of significant hydrocarbons. No quantitative estimate of resources was made.

UNCONVENTIONAL PLAY

Continuous-Type Play

3505. BASIN-CENTER GAS PLAY (HYPOTHETICAL)

This play is characterized by an extensive and continuous overpressured gas accumulation trapped in low permeability in Paleocene and uppermost Cretaceous sandstone reservoirs in deep parts of the Wind River Basin. The play is characterized by overpressuring due to active generation of gas. Older Cretaceous rocks, which may also be geopressured, are not considered because of their generally thin reservoir development and limited reservoir volumes.

Reservoirs: Principal reservoirs are sandstone beds in the Fort Union, Lance, and Mesaverde Formation. They are generally arkosic or lithic, with poor to modest porosity and low permeability. They are typically alluvial sandstones, particularly localized channel bodies of limited extent, and marine sandstone of more blanket-like character. The overall sequence displays significant internal compartmentalization.

Source rocks: Source rocks are directly associated humic-rich rocks and coals, with some contribution possible from underlying Cretaceous units. Gas appears to be thermogenic.

Timing and migration: The timing of generation and migration of hydrocarbons is favorable with reference to the available reservoirs. Overpressuring due to active generation of gas appears to generally coincide with R_o of 1.0 percent or more. This play is defined vertically by the approximate R_o=1.0 occurrence at the top of the involved section, which is approximately at 10,000 ft, and encompasses underlying Paleocene and upper Cretaceous rocks to the base of the Mesaverde Formation.

Traps: The trap is primarily a regional stratigraphic trap caused by low reservoir permeability combined with active gas generation. Alluvial sandstones, particularly localized channel bodies of limited extent, provide internal compartmentalization. Sealing is provided within the low-permeability reservoirs and by associated fine-grained rocks, variously Paleocene and uppermost Cretaceous. Ground-water influx and hydrodynamic enhancement may contribute to trapping.

Exploration status: This play has seen virtually no meaningful exploration and is speculative in nature. Field development has not yet taken place.

Resource potential: The resource potential of this high risk play is uncertain.

Coal-Bed Gas Play

By Ronald C. Johnson and Dudley D. Rice

One play, the Wind River Basin–Mesaverde Play (3550) has been identified in the Wind River Basin Province.

The coalbed gas potential of the Wind River Basin, central Wyoming has been evaluated by Rieke and Kirr (1984) and Johnson and others (1993). The work by Johnson and others (1993) is restricted to the Wind River Indian Reservation, which occupies part of the Wind River Basin.

In the basin, significant coal deposits are in the Upper Cretaceous Mesaverde and Meeteetse Formations and Paleocene Fort Union Formation. In a north-south trending belt in the west-central part of the basin, the cumulative thickness of Mesaverde coal, in beds 2 ft or thicker, is as much as 100 ft. East and west of this trend, the total thickness of Mesaverde coal thins to less than 20 ft. The Meeteetse Formation contains coal throughout the basin, but the cumulative thickness, in beds 2 ft or thicker, is generally less than 20 ft. However, as much as 40 ft of Meeteetse coal has been identified in the west-central part of the basin, near the thickest occurrence of coals in the underlying Mesaverde. The Fort Union Formation contains significant coal resources in a broad area along the southern flank of the basin. Cumulative thicknesses of Fort Union coal as much as 100 ft, in beds 2 ft or thicker, occur in two areas in the western and central parts of the basin.

The rank of Mesaverde and Meeteetse coal beds varies from lignite at or near the surface to anthracite at depths more than 18,000 ft along the deep-basin trough. The rank of Fort Union coal beds ranges from subbituminous C near the surface to high-volatile A bituminous at a depth of 11,000 ft. Thermogenic coalbed gas was probably generated while the basin was under maximum aggradation, about 35–10 Ma.

The coalbed gases consist mainly of methane, but also contain variable amounts of heavier hydrocarbon gases (as much as 4.6 percent) and CO_2 (as much as 6.5 percent). Isotopic data indicate that the gases are a complex mixture of biogenic and thermogenic origin.

The Wind River Basin is a structural and sedimentary basin that is narrow and deep. The basin is more than 170 mi long, but only 60 mi wide at its widest place. The coal-bearing interval, which crops out along the western and southwestern flanks of the basin, plunges to depths greater than 19,000 ft in a distance less than 5 mi. These steep dips limit the area where coal beds occur at depths favorable for recovery of coalbed gas (less than 6,000 ft). The basin contains numerous anticlinal structures, and limited information suggests that these structures may have enhanced cleat systems in the coal.

Gas contents as much as 115 Scf/t have been measured to depths of 1,000 ft. However, no information is available on gas content at greater depths. Earlier work indicated that about 2.2 TCF of in-place coalbed gas resources may be present in the basin. Recent work in the Wind River Indian Reservation suggests a resource base of as much as 6 TCF for Mesaverde coal beds to depths of 9,000 ft.

Minor amounts of coal have been mined at several localities in the western part of the basin. No mining activity is currently taking place.

In 1990, a gas well completed in a deeper zone was recompleted in Mesaverde coal beds at depths of about 3,200 to 3,840 ft. The well is located on the Riverton Dome in the southwest part of the basin. The well produced as much as 233 MCFG/D and was shut in after producing about 45 MMCFG and 52,000 bbl of water. This is the only known coalbed gas well in the basin. The Wind River Basin is a major gas-producing basin and the basic infrastructure is in place for the development of coalbed gas.

3550. WIND RIVER–MESAVERDE PLAY

The best potential for reserves of coalbed gas in the Wind River Basin is from Mesaverde coal beds. The Meeteetse coals are generally too thin, but multiple-seam completions with Mesaverde coals may be possible in areas where coals in both formations are thick. Fort Union coals are not considered to be prospective because of their low rank and anticipated low gas contents, although data are not available. One coalbed gas play is identified, the Wind River-Mesaverde Play (3550), and it occurs in the southwestern part of the basin where the Mesaverde coal beds are (1) at depths of 300 to 6,000 ft, and (2) at least 20 ft thick, but generally in the range of 30 to 50 ft thick. This is the area where coalbed gas has been produced from one well. The potential for reserves of coalbed gas for this play is estimated to be fair to poor because the coals probably have low gas contents at significant depths. However, not much information is available on the coals at depths greater than 1,000 ft.

REFERENCES

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